Cortical Hemodynamic Profiles and Brain Synchronization as Functional Biomarkers during Ensemble Performance: A Systematic Review of fNIRS Studies

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Abstract:

Ensemble musical performance demands high-level sensorimotor synchronization (SMS), potentially serving as a non-pharmacological pathway for neurocognitive preservation. Previous research shows that ensemble performance involves specific cortical areas, particularly the prefrontal cortex (PFC), which is responsible for executive function, inhibitory control, and working memory, as well as the temporoparietal junction (TPJ), which is central to Theory of Mind (ToM) processes, mentalization, and the distinction between the self and others. This systematic review evaluates functional Near-Infrared Spectroscopy (fNIRS) hyperscanning data, assessing cortical hemodynamics (Delta HbO) and Interpersonal Neural Synchronization (INS) as functional biomarkers of socio-motor integration. This fNRIS method has a much higher tolerance for head and body movements, making it an ideal tool for studying ensemble performance, where complex body movements, face-to-face communication, and sensorimotor synchronization are essential. Method of this study is following PRISMA guidelines, PubMed, Scopus, and Web of Science were searched for fNIRS studies comparing joint ensemble performance to solo/asynchronous conditions in healthy adults. Outcomes included regional oxyhaemoglobin (Oxy Hb) and Interpersonal neural synchronization (INS). Preliminary synthesis indicates that ensemble performance elicits significantly higher oxyhaemoglobin activation in temporo-parietal regions during duo performance compared to solo performance (p= 0.02) and higher interpersonal neural synchronization in the medial prefrontal cortex during teamwork drummer. This study concluded elevated prefrontal-motor activation and inter-neural coherence serve as dynamic functional biomarkers for socio-motor integrity during joint action. Establishing this baseline highlights a critical literature gap, emphasizing the need for future hyperscanning research into complex communal arts to fully elucidate the neuroprotective architecture of joint action.